A preliminary study on air microorganism in a wood mill

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Abstract: The air microbial species and quantities in a wood mill in Harbin, China were measured using sedimentation plate method. Results showed that the microbial quantity in the air at the workshop without depurator (54939 cfu·m^{-3}) was 2.1 times that of the workshop with depurator (25768 cfu·m^{-3}). The depurator could purify air microorganisms at the workshop, with a purifying rate of 53.1%, but it did not reach the standards of clean air. Comparatively the depurator is effective in reducing the quantity of air actinomyces, and some kinds of air actinomyces, such as *Scabies*, *Cinereas* and *Hygroscopicas*, can be clean out, but it is not very effective to bacteria and fungi. It is suggested that more effective and feasible methods should be developed for purifying air microorganisms at the workshop in the future.
Keywords: Air microorganism; Method of sedimentation plate; Purifying rate; Depurator
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Introduction

Pathogenic microorganism in the air is closely related to the life and health of the human beings, especially pathogenic microorganism endangers the health of human beings and pollutes the environment (Zhang 2004). Many pathogenic microorganisms could cause lots of respiratory tract diseases. Workers, longtime staying at the workshop, will be endangered very deep (Yuan *et al.* 2004). Therefore, it is very necessary to detect the microbial quantities at workshop in different situations. In this study, the purifying rate of the depurator was detected. The purpose of this experiment is, by surveying the efficiency of the current widely used depurator, to provide the base on seeking more effective and feasible methods of controlling air pollution and improving the quality of air at the workshop (Xu *et al.* 2003).

Materials and methods

Sampling

A wood mill in Harbin was chosen as sampling site. Two plots (3 m x 3 m), one plot at the workshop without depurator, named A_1 and the other at the workshop with depurator, named A_2, were selected to sample the air in January 2004. Each plot was further divided into five subplots (a centre and four corners of each plot).Three kinds of solid culture media were adopted in this experiment. Peptone medium,Gao No I medium, and Martin's medium were used to culture bacteria, actinomyces, and fungi, respectively (Soil Research Institute in Nanjing 1985). At every subplot, three different kinds of solid culture media were placed, and each kind of media had five replicates. The bacteria, fungi, and actinomyces were collected with the sterile culture plates in 5 min, 10 min, and 20 min, respectively (Zhong *et al.* 2004).

Cultivation and identification of microorganism

The plates with Peptone medium were incubated in a dark-growth incubator at 37 °C. Two days later, the total number of developed bacteria colonies was counted. The plates with Martin's medium and the plates with Gao No I medium were incubated in a dark-growth incubator at 25–28 °C, and five days later, the total numbers of developed fungi and actinomyces colonies were counted respectively. Subsequently, these actinomyces colonies were identified by the methods of colony morphology and the actinomyces growth (Zhang 1990).

Data analysis

Numbers of air microbial colonies on the culture plates (cfu·m^{-3}) were calculated with the following Equation (Liu *et al.* 2004).

$$X = (N\times100\times100) / (3.14\times R^2)$$

where, X is numbers of air microbial colonies (cfu · m^{-3}), N is average cfu (colony formation unit) per plate, and R is radius of the culture plate (R=4. 5 cm).

Results and analysis

The quantities of microorganisms at different subplots

The quantities of three kinds of air microbial colonies on the culture plates (cfu·plate-1) were computed. The quantities of bacteria, fungi and actinomyces in the air at the workshop without depurator were 2.0 times, 3.1 times and 8.2 times higher than those at workshop with depurator, respectively (Table 1). Depurator could purify bacteria, fungi and actinomyces in air at the workshop, but its purifying rate for three kinds of microorganisms was different. The rate of purifying actinomyces was the highest, while the rate of purifying bacterial was the lowest (Table 1).

The total quantity of microorganisms at workshop with depurator was half of that at workshop without depurator. It indicated that the depurator could purify air microorganisms at the workshop and purifying rate reached 53.1% (Table 2).

The bacterial quantity was higher at workshop without depurator than at that with depurator. After the depurator was used at workshop, the bacterial quantity, which had been reduced by 50.8%, was still 24 471 cfu · m^{-3} (Table 2). According to the sanitary standards of air, the bacterial quantity should be

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under 4 500 cfu · m^{-3}, and the normal range of bacterial quantity allowed is 4 500–7 000 cfu · m^{-3} (Xu *et al.* 2004). Moreover, the bacterial quantity (24 471 cfu · m^{-3}) at workshop with depurator was above the limit of normal range. Therefore, the depurator was not very effective, by which the quantity of air microorganisms in purified air did not reach the standards of clean air. So other depurating methods should be taken simultaneously.

The identification of air actinomyces

Six kinds of actinomyces groups identified at workshop were *Albus, Scabies, Cinereas, Fradia, Hygroscopicas, Reticuli* (Table 3). Using depurator not only reduced the total quantity of air actinomyces but also clean out some kinds of air actinomyces, such as *Scabies, Cinereas* and *Hygroscopicas,*.at the same time, the quantities of *Fradiae* and *Albus* were reduced by 88.9% and 83.3%, but there was no change on the quantity of *Reticuli*. However, the quantities of bacteria and fungi were not reduced to the standards of clean air by using depurators, so depurator was not very effective to bacteria and fungi.

Table 1. The quantities of three kinds of microorganisms at different subplots (cfu·plate^{-1})

Sampling plots	Groups	Subplots					Average	Purifying rate
		Corner 1	Corner 2	Corner 3	Corner 4	Centre of plot		
A_1 (workshop without depurator)	Bacteria	291.7	328.8	287.1	337.5	301.5	316.5	
	Fungi	45.1	46.3	43.2	55.2	45.8	47.1	
	Actinomyces	32.0	24.0	36.0	20.0	36.0	29.6	
A_2 (workshop with depurator)	Bacteria	161.7	153.6	148.5	165.6	148.7	155.6	50.8%
	Fungi	13.3	15.1	15.1	16.3	15.3	15.0	68.2%
	Actinomyces	3.0	2.0	5.0	4.0	4.0	3.6	87.8%

Table 2. The total quantities of air microorganisms at different plots

Sampling plots	Bacteria		Fungi		Actinomyces		Total (cfu·m^{-3})	Purifying rate
	N	X	N	X	N	X		
A_1 (workshop without depurator)	316.5	49776	77.8	3708	5.7	1455	54939	
A_2 (workshop with depurator)	47.1	24471	7.5	1140	0.9	157	25768	53.1%

Notes: X--- numbers of air microbial colonies (cfu·m^{-3}); N --- average cfu (colony formation unit) per plate.

Table 3. Results of identification of air actinomyces at the workshop

Trial number	Name of Group	Black stain	Aerial mycelium	Substrate mycelium	Number	
					A_1	A_2
1	(*Albus*)	–	white	colorless	12	2
2	(*Scabies*)	+	gray	brown to black	2	
3	(*Cinereas*)	–	white to gray	colorless to yellow	4	
4	(*Fradiae*)	–	pink to rosiness	yellow to orange	9	1
5	(*Hygroscopicas*)	+	white to gray	taupe	1	
6	(*Reticuli*)	–	white to gray	colorless	1	1

Notes: (+)---actinomyces produce blank stain; (-)---the actinomyces don't produce blank stain; A_1---workshop without depurator; A_2---workshop with depurator.

Conclusions and discussion

In the tested wood mill, the total microbial quantity at the workshops without depurator and with depurator was 54 939 cfu · m^{-3} and 25 768 cfu · m^{-3}, respectively. The microbial quantity without depurator was 2.1 times higher than that of the workshop with depurator. Among the three kinds of air microorganisms tested, the quantity of bacteria was the highest, followed by Fungi.

This research shows that, to some extent, the depurator has effect on reducing the quantities of bacteria, actinomyces and fungi, but the purifying rate is very different for different kinds of microorganisms. Comparatively, the depurator was not very effective to bacteria and fungi, so other depurated methods should be taken simultaneously to reduce the populations of bacteria and fugi. Therefore, more effective and feasible methods should be developed, exploited and applied in the future.

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